CERTIFICATE OF VERIFICATION

I, Su Hyun LEE of 648-23 Yeoksam-dong, Kangnam-ku, Seoul, Korea state that the attached document is a true and complete translation to the best of my knowledge of the Korean-English language and that the writings contained in the following pages are correct English translations of the specifications and claims of the Korean Patent Publication No. P1999-18970.

Dated this 27th day of January 2005

Signature of translator: ____________

Su Hyun LEE

[ABSTRACT OF THE DISCLOSURE] 99-18970

[ABSTRACT]

A transmission-reflection type liquid crystal display device is disclosed, for being driven as the transmission type or the reflection type by selection of a user, depending on an external environment, which includes a first transparent substrate and a second transparent substrate wherein the plural pixel regions are defined; a liquid crystal layer formed between the first transparent substrate and the second transparent substrate; a linear polarizer provided on the second transparent substrate; a circular polarizer provided on the first transparent substrate; and a reflecting film provided on the first transparent substrate, for being positioned between the circular polarizer and the liquid crystal layer, and provided on the first transparent substrate of regions except a light-transmittable region, in order to form the light-transmittable region on every pixel region of the first transparent substrate.

[TYPICAL DRAWINGS]

FIG. 1

[INDEX]

reflection type, transmission type, cholesteric liquid crystal polarizer, CLC

[SPECIFICATION]

[TITLE OF THE INVENTION]

TRANSMISSION-REFLECTION TYPE LIQUID CRYSTAL DISPLAY DEVICE

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 is a sectional view showing a transmission-reflection type liquid crystal display device according the present invention.

FIG. 2A and FIG. 2B are views showing the progress of light in case that the transmission-reflection type liquid crystal display device according to the present invention acts as a reflection type.

FIG. 3A and FIG. 3B are views showing the progress of light in case that the transmission-reflection type liquid crystal display device according to the present invention acts as a transmission type.

FIG. 4 is a plane view showing a structure of electrodes in the liquid crystal display device according to the present invention.

FIG. 5 is a plane view showing a structure of electrodes in the liquid crystal display device according to the conventional art.

[DETAILED DESCRIPTION OF THE INVENTION]

[OBJECT OF THE INVENTION]

[FIELD OF THE INVENTION AND DISCUSSION OF THE RELATED ART]

The present invention relates to a liquid crystal display device, and more particularly, to a reflection type liquid crystal display device that can act as a transmission type, too.

A liquid crystal display device (LCD) as a flat plate type display is widely used for a display device of portable computers or portable televisions.

A liquid crystal display device is classified into two types according to a way to use a light source. One is a transmission type liquid crystal display device using a backlight provided on the back face of a liquid crystal panel as a light source, and the other is a reflection type liquid crystal display device using an external light source such as sunlight or an indoor lamp.

It is hard to decrease the volume, weight and the power consumption of a transmission type LCD device because of the backlight that is used as a light source. And, in case of a reflection type liquid crystal display device, the volume, weight and the power consumption is low because it doesn't need to use the backlight. But, if an external environment is dark, the reflection type liquid crystal display device cannot be used.

[TECHNICAL TASKS TO BE ACHIEVED BY THE INVENTION]

Accordingly, the present invention is directed to a transmission-reflection type liquid crystal display device that substantially obviates one or more problems due to limitations and disadvantages of the related art.

An object of the present invention is to provide a transmission-reflection type liquid crystal display device that can be driven as a reflection type as well as a transmission type.

To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, a transmission-reflection type liquid crystal display device includes a first transparent substrate and a second transparent substrate wherein the plural pixel regions are defined; a liquid crystal layer formed between the first transparent substrate and the second transparent substrate; a linear polarizer provided on the second transparent substrate; a circular polarizer provided on the first transparent substrate; and a reflecting film provided on the first transparent substrate, for being positioned between the circular polarizer and the liquid crystal layer, and provided on the first transparent substrate of regions except a light-transmittable region, in order to form the light-transmittable region on every pixel region of the first transparent substrate.

[PREFERRED EMBODIMENTS OF THE INVENTION]

Hereinafter, a transmission-reflection type liquid crystal display device according to the present invention will be described with reference to the accompanying drawings.

As shown in FIG. 1, a liquid crystal display device according to the present invention includes a first transparent substrate 2 and a second transparent substrate 6 wherein the plural pixel regions are defined; a liquid crystal layer 4 formed between the first transparent substrate 2 and the second transparent substrate 6; a linear polarizer 8 and a phase shift-plate of 1/4 wavelength 7 provided on an external side of the second transparent substrate 6; a color filter layer 5 and a transparent common electrode 10 provided on an inner side of the second transparent substrate 6; a right-handed cholesteric liquid crystal left-handed circular polarizer 1 which is provided on an outer

side of the first transparent substrates 2 and makes a light in a region of visible lights form left-handed circular polarization; and a reflecting film 3 provided on the inner side of the first transparent substrate 2.

The reflecting film 3 is formed from that a metal layer such as aluminium Al is deposited on the first transparent substrate 2 and then patterned thereon. Also, the reflecting film 3 is formed on every pixel region. In this case, although not illustrated in the drawing, the reflecting film 3 is electrically insulated from a reflecting layer of another pixel region and the reflection film 3 is connected with a thin film transistor (TFT, not shown in the drawing) formed on every pixel region of the first transparent substrate 2, so that the reflecting film 3 functions as a pixel electrode. The thin film transistor TFT functions as a switching element for transmitting a pixel voltage to the reflecting film 3. If the pixel voltage is transmitted to the reflecting film 3, the pixel voltage is applied to the liquid crystal layer 4 positioned between the reflecting film 3 and the transparent common electrode 10, depending on the pixel voltage, so that the arrangement of liquid crystal molecules is controlled by the pixel voltage. A light-transmittable region 9 through which a light can be transmitted is formed on every pixel region of the first transparent substrate 2, and the reflecting film 3 is formed in the pixel region except the light-transmittable region 9. The multiple gate lines and data lines (not shown in the drawing) are formed on the first transparent substrate 2, wherein each gate line is arranged in perpendicular to each data line, thereby defining the plural pixel regions.

The right-handed cholesteric liquid crystal left-handed circular polarizer 1 comprises a right-handed helical cholesteric liquid crystal having a pitch ($p=\lambda/n$, wherein, 'p' is a pitch, 'λ' is a wavelength of a region of visible lights, and 'n' is an

average index of refraction of an extraordinary ray and an ordinary ray). That is, the cholesteric liquid crystal includes all pitches having a range of (380nm~800nm)/n, also only a right-handed circularly polarized element is reflected in the light of region of visible lights and the other elements of the light are transmitted through the circular polarizer 1. In other words, the left-handed circular polarizer 1 makes only left-handed circularly polarized elements transmit.

The liquid crystal layer 4 is oriented to allow the phase shift of 4/1 wavelength into lights of a region of visible lights which pass through the liquid crystal layer 4 in the state to which a voltage is not applied, and the orientation of the liquid crystal is decided by the two oriented layers (not shown in the drawing) which are adjacent to each upper and lower faces of the liquid crystal layer 4.

In order to allow the phase shift of 1/4 wavelength to the lights, the phase shift-plate of 1/4 wavelength 7 has an interval angle of 45° between a slow axis in the phase shift-plate of 1/4 wavelength 7 and a polarization axis of the linear polarizer (direction of linear polarization).

Hereinafter, in the case that the liquid crystal display device according to the present invention is operated as a reflection type, it will be described with reference to FIG. 2A and FIG. 2B. Also, the progress direction of light is shown on the basis of an observer confronting with the second transparent substrate 6 in the drawing.

As shown in FIG. 2A, in the case that the pixel voltage is not applied to the reflecting film 3, only parallel linearly polarized elements with the polarization axis of the linear polarizer in the incident rays from the outer lights pass through the linear polarizer 8. As the linearly polarized light passes through the phase shift-plate 7, it becomes right-handed circular polarization. Then, as the right-handed circularly

polarized light passes through the liquid crystal layer 4, it becomes linear polarization to the perpendicular direction against the polarization axis of the linear polarizer 8, and then is incident on the reflecting film 3. As the linearly polarized light reflected on the reflecting film 3 passes through the liquid crystal layer 4, it becomes right-handed circular polarization. Then, as the light passes through the phase shift-plate 7, it becomes the linear polarization having a parallel direction against the polarization axis of the linear polarizer 8. Therefore, the light passes through the linear polarizer 8 just as it is, so that bright image (white) is displayed.

In the case that the maximum pixel voltage is applied to the reflecting film 3, as shown in FIG. 2B, only parallel linearly polarized elements with the polarization axis of the linear polarizer 8 in the incident rays entering from the outer lights pass through the linear polarizer 8. The linearly polarized light passes through the phase shift-plate 7, and it becomes right-handed circular polarization. Then, the right-handed circularly polarized light passes through the liquid crystal layer 4 just as it is, and enters the reflecting film 3. The right-handed circularly polarized light entering the reflecting film 3 is reflected on the reflecting film 3, and then is changed into left-handed circular polarization, and passes through the liquid crystal layer 4 just as it is. Furthermore, the light passes through the phase shift-plate 7, and becomes linear polarization having a perpendicular direction against the polarization axis of the linear polarizer 8. Therefore, the light doesn't pass through the linear polarizer 8, so that dark image (black) is displayed.

Hereinafter, in the case that the liquid crystal display device according to the present invention is operated as a transmission type, it will be described with reference to FIG. 3A and FIG. 3B. Also, the progress direction of light is shown on the basis of

an observer confronting with the second transparent substrate 6 in the drawing.

In the case that the pixel voltage is not applied to the reflecting film 3, as shown in FIG. 3A, the light generated from a backlight (not shown in the drawing) which is provided on the position confronting with the left-handed circular polarizer 1 enters the left-handed circular polarizer 1. Then, only the left-handed circularly polarized elements in the region of the visible lights in the incident rays pass through the left-handed circular polarizer 1, also the left-handed circularly polarized lights pass through the light-transmittable region 3, and then pass through the liquid crystal layer 4, so that the lights become linear polarization having a perpendicular direction against polarization axis of the linear polarizer 8. Furthermore, the linearly polarized lights pass through the phase shift-plate 7, so that form the left-handed circular polarization, and only linearly polarized elements having the parallel direction against the polarization axis of the linear polarizer 8 in the left-handed circularly polarized lights pass through the linear polarizer 8. As a result, bright image (white) is displayed.

In the case that the maximum pixel voltage is applied to the reflecting film 3, as shown in FIG. 3B, lights generated from the backlight enter the left-handed circular polarizer 1. And, only the left-handed circularly polarized elements in the region of the visible lights in the incident rays pass through the left-handed circular polarizer 1. Furthermore, the left-handed circularly polarized lights pass through the light-transmittable region 9, and then pass through the liquid crystal layer 4 just as it is, also pass through the phase shift-plate 7, so that become linear polarization having the perpendicular direction against the polarization axis of the linear polarizer 8. Therefore, the lights are intercepted by the linear polarizer 8 so that dark image (black) is displayed.

FIG. 4 is a plane view showing a structure of electrodes provided on the first transparent substrate 2 of FIG. 1. And, only one pixel region is represented for convenience' sake. A common region of regions between adjacent two gate lines 25 and adjacent two data lines 24 defines one pixel region.

The reflecting film 3 is connected with a drain electrode 23 of the thin film transistor TFT, a gate electrode 22 of the thin film transistor TFT is connected with the gate line 25, and a source electrode 21 of the thin film transistor TFT is connected with the data line 24.

In the general reflection type liquid crystal display device, as shown in FIG. 5, the reflecting film 35 is overlapped with the every inner edge of the gate line 25 and the data line 24, in order to form a storage capacitance. In FIG. 5, components having the same structure with components shown in FIG. 4 represent as the same numbers, and the explanation is omitted. In this case, although not illustrates in the drawing, the gate line 25 and the data line 24 are insulated from each other by an insulating layer provided between the gate line and the data line, and the data line 24 and the reflecting film 3 are insulated from each other by an insulating layer provided between the data line and the reflecting film. However, in this present invention, in order to form the light-transmittable region 9 represented by a deviant crease, the edge of the lower side and the right side in the reflecting film 3, adjacent gate line 25, and data line 24 have regular intervals to prevent overlapping each other. Also, in order to form the storage capacitance, the edge of the upper side and the left side in the reflecting film 3 is overlapped with the greater part of the gate line 25 and the data line 24.

[ADVANTAGES OF THE INVENTION]

As mentioned above, the transmission-reflection type liquid crystal display device according to the present invention has the following advantages.

The transmission-reflection type liquid crystal display device according to the present invention can be driven as the transmission type or the reflection type by selection of a user, depending on an external environment.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A transmission-reflection type liquid crystal display device comprising:

a first transparent substrate and a second transparent substrate wherein the plural pixel regions are defined;

a liquid crystal layer formed between the first transparent substrate and the second transparent substrate;

a linear polarizer provided on the second transparent substrate;

a circular polarizer provided on the first transparent substrate; and

a reflecting film provided on the first transparent substrate, for being positioned between the circular polarizer and the liquid crystal layer, and provided on the first transparent substrate of regions except a light-transmittable region, in order to form the light-transmittable region on every pixel region of the first transparent substrate.

2. The transmission-reflection type liquid crystal display device as claimed in claim 1, wherein a phase shift-plate of 1/4 wavelength is additionally formed between the linear polarizer and the liquid crystal layer,

in the state that a voltage is not applied to the liquid crystal layer, liquid crystal molecules of the liquid crystal layer are oriented to provide phase shift by 1/4 times of the wavelength of visible light to a light of transmitting the liquid crystal layer,

and also the circular polarizer includes a right-handed helical cholesteric

liquid crystal having a pitch value of (380㎚~800㎚)/n ('n': average index of refraction of cholesteric liquid crystal).

3. The transmission-reflection type liquid crystal display device as claimed in claim 1, wherein the plural gate lines and data lines are formed on the first transparent substrate in the state that each gate line is perpendicular to each data line,

the pixel region is defined from a common region of a region between the adjacent two gate lines and a region between the adjacent two data lines,

the reflecting film is formed on every pixel region,

a part of edge of the reflecting film is folded each other between a part of the two lines and an insulating layer, and the opposite edge is apart from the parallel direction against the two lines and the first transparent substrate at regular intervals.

FIG.1

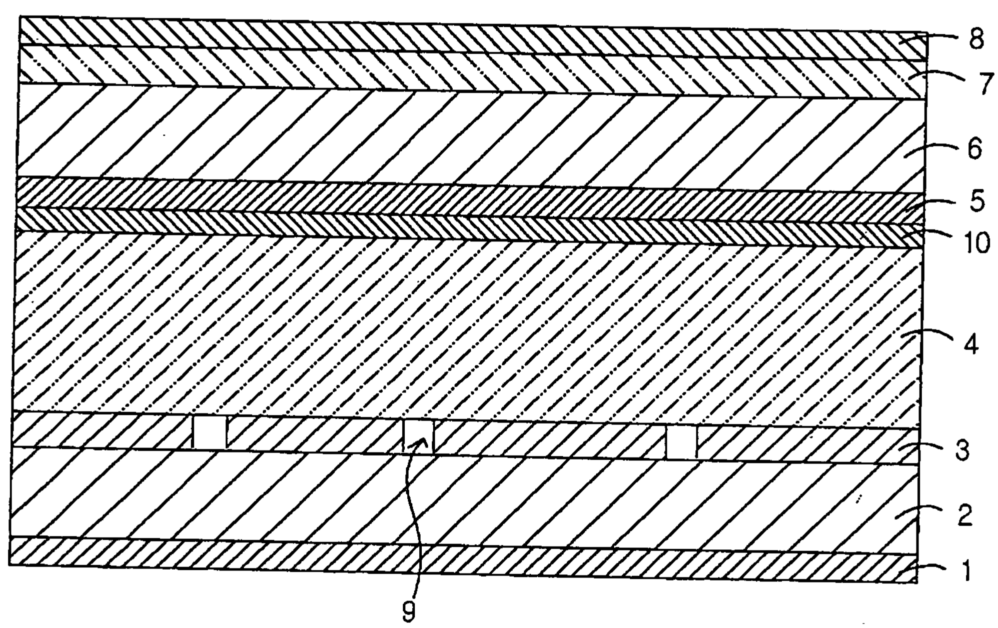

FIG.2A

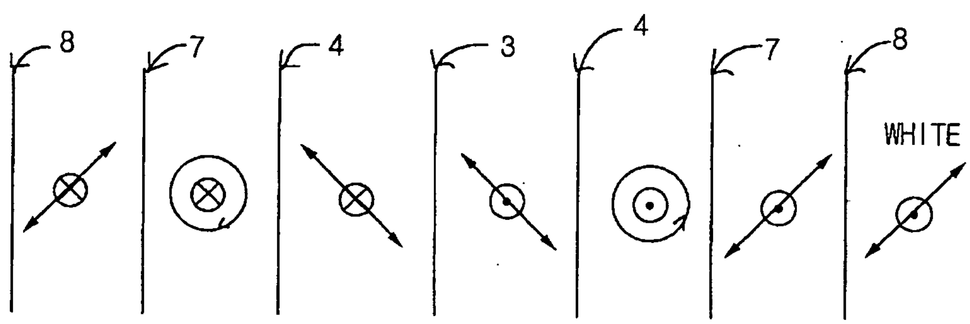

FIG.2B

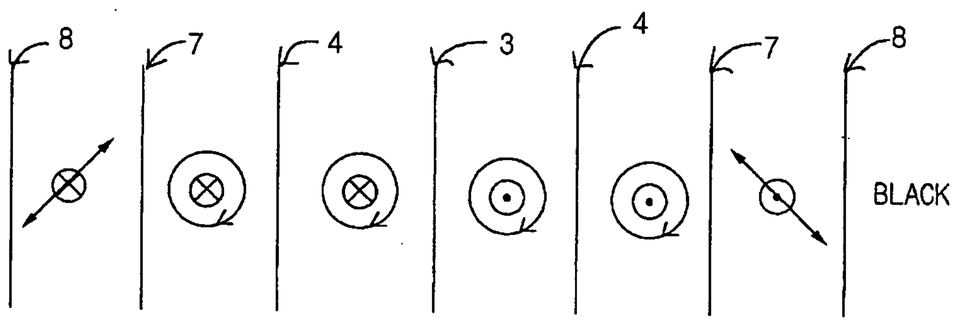

FIG.3A

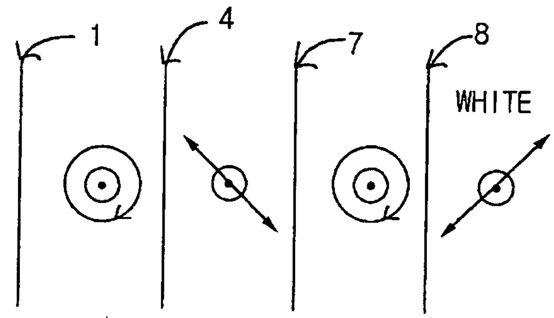

FIG.3B

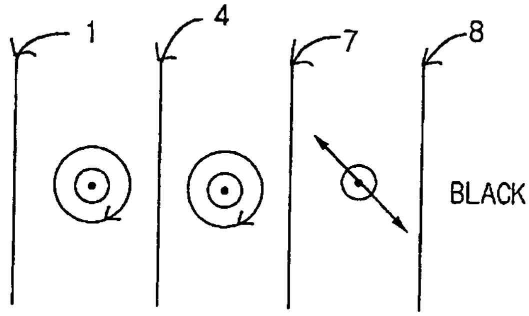

FIG.4

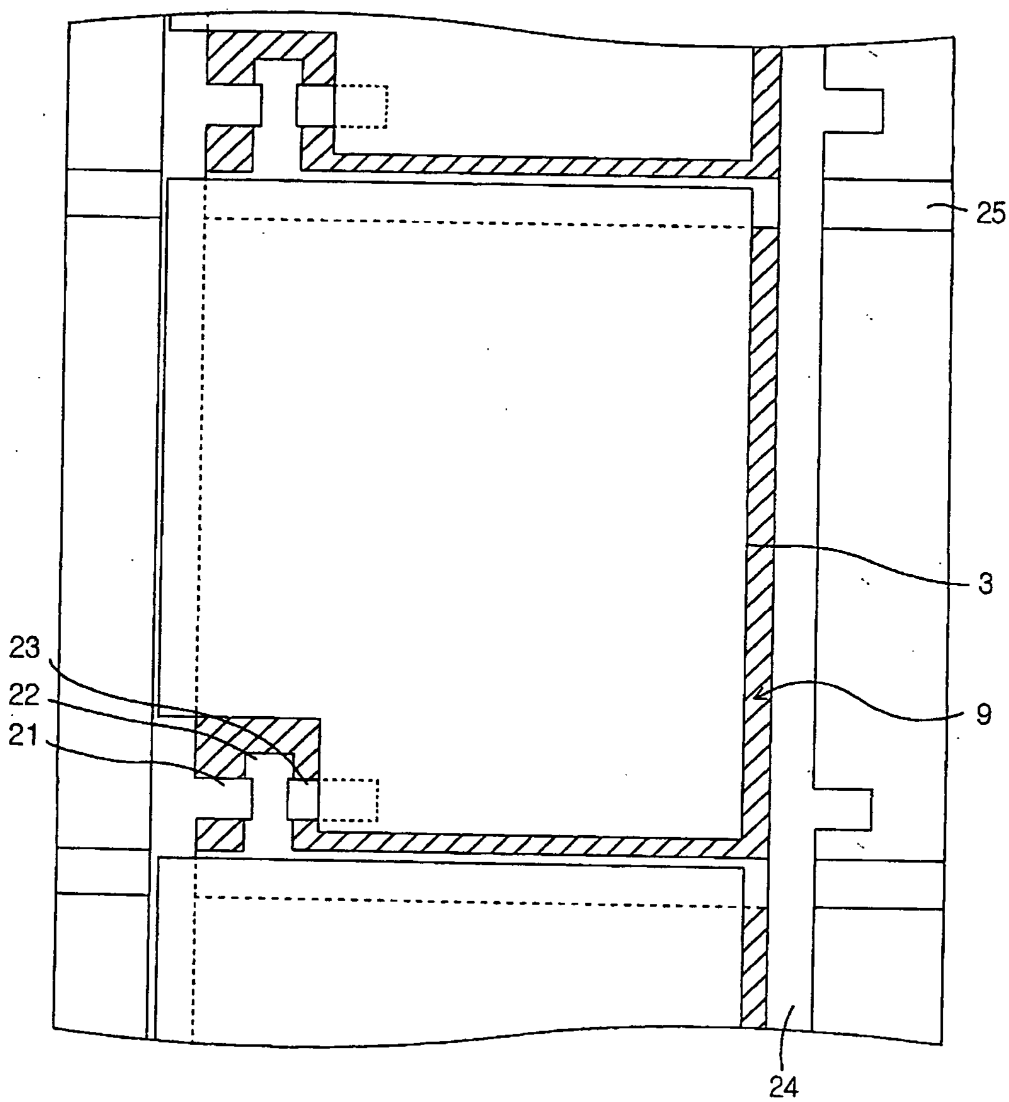

FIG.5
PRIOR ART